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(54) METHOD AND SYSTEM FOR GAS-LIFTING WELL EFFLUENTS

VERFAHREN UND VORRICHTUNG ZUR GASLIFTFÖRDERUNG VON BOHRLOCHFLÜSSIGKEITEN

PROCEDE ET SYSTEME PERMETTANT L'EXTRACTION PAR EJECTION (GAZ-LIFT) D'EFFLUENTS DE PUITS

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Description

Background of the invention

[0001] The invention relates to a method and system for gas-lifting well effluents by injecting lift-gas downhole into the stream of well effluents.

[0002] Such a method and system are known, for example, from US patent No. 5,562,161.

[0003] In the known system lift-gas is injected through a gas injection port into the production tubing of an oil well.

[0004] The lift-gas reduces the average density of the well effluents in the production tubing so that the oil production is enhanced if lift-gas is injected at an appropriate injection rate.

[0005] A drawback of the known lift-gas injection techniques is that the injected gas may immediately form gas (Taylor) bubbles which gradually grow as a result of the gradually decreasing hydrostatic pressure when the fluids flow from the production zone at a depth of a few kilometres beneath the surface to the wellhead which is at or near the earth surface. These expanding gas (Taylor) bubbles may bypass the oil so that an unstable flow regime is created and in extreme cases mainly lift-gas is produced and hardly any oil.

[0006] The present invention aims to alleviate this drawback of the conventional lift-gas injection techniques by providing a gas lift technique wherein the risk of lift-gas rapidly slipping through the produced crude oil is reduced. WO 99/11905 describes such a technique utilising mixing elements.

Summary of the Invention

[0007] In the method according to the invention lift-gas is injected as an agglomerate of finely dispersed bubbles into the stream of well effluents.

[0008] Preferably this is achieved by injecting the lift-gas through a porous wall in which an array of injection ports is present which have an average width less than 0.5 mm, preferably less than 0.1 mm.

[0009] Suitably said porous wall is formed by a porous membrane and the porous wall has a tubular shape and forms part of a tubular gas injection mandrel. It is releasably inserted in a side pocket of a production tubing such that in use lift-gas is injected via an annular space surrounding the production tubing into the interior of the mandrel and then is ejected via the porous wall into the stream of well effluents in the production tubing.

[0010] The system according to the invention comprises a porous wall in which an array of lift-gas injection ports is present, through which ports in-use lift-gas is injected as an agglomerate of finely dispersed bubbles into the stream of well effluents.

Description of a preferred embodiment

[0011] The invention will be described in more detail, by way of example with reference to the accompanying drawings. which show various embodiments of the dispersed ligt-gas injection system according to the invention, and in which:

Fig. 1 depicts a schematic longitudinal sectional view of a crude oil production well in which a dispersed lift-gas injection mandrel is retrievably inserted in a side pocket of a production tubing;
Fig. 2 depicts a schematic longitudinal sectional view of a crude oil production well tubing joint in which a porous dispersed lift-gas injection sleeve is mounted;
Fig. 3 depicts a schematic longitudinal sectional view of a crude oil production well tubing in which a porous dispersed lift-gas injection sleeve is arranged in a retrievable manner;
Fig. 4 depicts a schematic cross-sectional view of well which is equipped with a hub- and spoke configuration of a retrievable segmented dispersed lift-gas injection assembly; and
Fig. 5 depicts a schematic cross-sectional view of a well which is equipped with a retrievable telescoping dispersed lift-gas injection assembly.

[0012] Fig. 1 shows a production tubing 1 through which crude oil is produced from a subsurface oil bearing formation to surface as illustrated by arrow 2.

[0013] The production tubing 1 depicted in Fig. 1 comprises a side pocket 3 in which a gas injection mandrel 4 is retrievably inserted and locked in place by a pin bottom latch 5.

[0014] In use lift-gas is injected from the annular space 6 surrounding the tubing 1 through a port opening 8 in the tubing and a series of port openings 9 in the wall of the mandrel 4 adjacent thereto, as illustrated by arrow 10.

[0015] The lift-gas then flows up through a check valve 11 and a tapered conduit section 12 into a slotted strength member 13. The lift-gas then passes through the slots 14 into an annulus surrounding the strength member 13, which annulus is surrounded by a porous ceramic membrane 15, which comprises an array of narrow openings having a width less than 0.5 mm. The lift-gas ejected through said array of narrow openings forms a large amount of small bubbles 16 which are finely dispersed in the produced crude oil.

[0016] The bubbles 16 and crude oil thus form an intimately mixed froth mixture such that the risk of slugs of lift-gas bubbles which bypass slugs of crude oil and create a violent unstable flow regime is reduced.

[0017] The lower part of the mandrel 4 comprises a bellow 17 in which a pressurized gas, such as nitrogen, is present, and which serves to regulate the opening of the check valve 11 such that a minimum pressure on the

gas side is maintained and reverse flow from the tubing 1 is prevented.

[0018] At the upper end of the mandrel 4 a fishing neck 18 is arranged which can be gripped by a fishing tool or well tractor to retrieve the mandrel 4 to surface for maintenance or replacement.

[0019] Fig. 2 depicts a tubing connection joint 20 having upper and lower screw thread connectors 21 between which a short piece of pipe 22 is welded in which a porous frited sleeve 23 is mounted by means of a set of ringshaped shoulders 24.

[0020] A lift-gas injection tube 25 is welded onto the outer surface of the pipe 22 and is in fluid communication with an annular space 26 between the inner surface of the pipe 22 and the outer surface of the porous frited sleeve 23 via an orifice 27 in the wall of the pipe 22.

[0021] The lift-gas injection tube 25 is equipped with a one-way check valve 28 and may be connected to a rigid or flexible lift-gas injection conduit 29 that extends from a wellhead (not shown) through the well casing-production tubing annulus (not shown). In use lift-gas is injected as indicated by the arrow 30 via the conduit 29, tube 25, orifice 27, annular space 26 and pores of the porous frited sleeve 23 into the interior of the sleeve 23 and of the production tubing whereby finely dispersed bubbles 31 of injected lift-gas and crude oil is created so that a froth-type of gas-liquid mixture is formed.

[0022] Fig. 3 shows an alternative embodiment of a dispersed lift-gas injection system according to the invention, wherein a porous frited sleeve 33 is retrievably inserted inside a production tubing 34 of a viscous crude oil production well by means of a pair of nitril rubber heels 35.

[0023] The sleeve 33 is arranged adjacent to an annular gas inlet chamber 36 into which lift-gas Is injected through a flexible lift-gas injection hose 37 as illustrated by arrow 38. The lift-gas passes through the pores of the porous frited sleeve 33 and forms a foam or froth-type of gas/liquid mixture 39 with the crude oil passing through the production tubing 34.

[0024] The sleeve 33 may be inserted and/or replaced by a wireline tool, which is equipped with an expandable bladder which exerts an expansive load on the rubber heels 36 during installation whereby the heels 36 are expanded against the inner wall of the production tubing 34 and may be locked in place by e.g. a spring type split ring or snap-lock ring (not shown).

[0025] Fig. 4 is a schematic cross-sectional view of a crude oil production well 40 which traverses an underground formation 41. A production tubing 42 is suspended in the well 40. Within the production tubing 42 a gas-lift assembly is arranged comprising a coiled lift-gas injection tube 43 and a hub and spoke configuration of three porous lift-gas sleeve segments 44 that are each mounted on a radial support pipe 45 via which in use lift-gas is injected from the coiled lift gas injection tube 43 into the interior of the porous sleeve segments 44.

[0026] The lift-gas migrates through the pores of the walls of the frited sleeve segments and subsequently mixes with the produced crude oil and forms a foam or froth of a crude oil liquid phase and finely dispersed gaseous bubbles 46.

[0027] The coiled lift-gas injection tube 43 and/or lift-gas injection segments 44 may be anchored to the production tubing 42 and/or may be provided with a ballast weight to maintain the tube 43 and segments 44 at a desired location in a lower part of the well, where lift-gas is to be injected into the production tubing 42.

[0028] The porous segments 44 may have a length of several metres and a series of segments 44 may be suspended at various depths in the well.

[0029] Fig. 5 illustrates yet another embodiment of a dispersed lift-gas injection assembly according to the invention. The assembly is arranged in a production tubing 50 of a crude oil production well 51, which traverses an underground formation 52. A lift-gas injection mandrel 53 is arranged and locked in a side pocket 54 of the production tubing 50 in a manner similar as illustrated in Fig. 1.

[0030] The mandrel 53 is equipped at its upper end with a telescoping assembly of porous sleeve segments 55. During installation the segments 55 are retracted so that the smaller segments 55 are substantially housed within the largest segment.

[0031] In use lift-gas is injected from the annulus surrounding the production tubing 50 via an orifice 56, the mandrel 53 into the interior of the porous segments 55. The elevated pressure of the injected lift-gas pushes the smaller segments 55 out of the largest segment in the extended position illustrated in Fig. 5.

[0032] The lift-gas migrates through the pores of the walls of the frited porous segments 55 and thus an array of finely dispersed micro-gas bubbles 56 is injected into the crude oil passing through the production tubing 55 so that a froth or foam gas/liquid mixture is formed and the tendency of the lift-gas to bypass the produced crude oil is reduced.

Claims

1. A method for gas-lifting well effluents (2) by injecting lift-gas (16) downhole into the stream of well effluents (2), **characterised in that** lift-gas (16) is injected as an agglomerate of finely dispersed bubbles (16) into the stream of well effluents (2).

2. The method of claim 1, wherein the lift-gas (16) is injected into the stream of well effluents (2) through a porous wall (15) in which an array of lift-gas injection ports is present.

3. The method of claim 2, wherein the average width of said injection ports is less than 0.5 mm.

4. The method of claim 3, wherein the average width

of said injection ports is less than 0.1 mm.

5. The method of claim 4, wherein said porous wall (15) is formed by a porous membrane.

6. The method of claim 2, wherein the porous wall (15) has a tubular shape and forms part of a tubular gas injection mandrel which is releasably inserted in a side pocket (3) of a production tubing (1) such that in use lift-gas (16) is injected via an annular space (6) surrounding the production tubing (1) into the interior of the mandrel (4) and then is ejected via the porous wall (15) into the stream of well effluents (2) in the production tubing (1).

7. A system for gas-lifting of well effluents (2), the system **characterised by** a porous wall (15) in which an array of lift-gas injection ports is present, through which ports in-use lift-gas (16) is injected as an agglomerate of finely dispersed bubbles (16) into the stream of well effluents (2).

Revendications

1. Procédé d'extraction au gaz d'effluents de puits (2) par l'injection au fond d'un gaz de poussée (16) dans le courant d'effluents de puits (2), **caractérisé en ce que** le gaz de poussée (16) est injecté sous la forme d'un agglomérat de bulles finement dispersées (16) dans le courant d'effluents de puits (2).

2. Procédé suivant la revendication 1, dans lequel le gaz de poussée (16) est injecté dans le courant d'effluents de puits (2) par une paroi poreuse (15) dans laquelle est agencée une rangée d'orifices d'injection de gaz de poussée.

3. Procédé suivant la revendication 2, dans lequel la largeur moyenne desdits orifices d'injection est inférieure à 0,5 mm.

4. Procédé suivant la revendication 3, dans lequel la largeur moyenne des orifices d'injection précités est inférieure à 0,1 mm.

5. Procédé suivant la revendication 4, dans lequel la paroi poreuse (15) précitée est formée d'une membrane poreuse. .

6. Procédé suivant la revendication 2, dans lequel la paroi poreuse (15) a une forme tubulaire et fait partie d'un mandrin d'injection de gaz tubulaire qui est introduit de façon amovible dans une poche latérale (3) d'un tube de production (1) de telle sorte qu'en cours d'utilisation le gaz de poussée (16) soit injecté via un espace annulaire (6) entourant le tube de production (1) à l'intérieur du mandrin (4) et ensuite soit éjecté via la paroi poreuse (15) dans le courant d'effluents de puits (2) dans le tube de production (1).

7. Système d'extraction au gaz d'effluents de puits (2), le système étant **caractérisé par** une paroi poreuse (15) dans laquelle est agencée une rangée d'orifices d'injection de gaz de poussée, orifices par lesquels en cours d'utilisation un gaz de poussée (16) est injecté sous la forme d'un agglomérat de bulles finement dispersées (16) dans le courant d'effluents de puits (2).

Patentansprüche

1. Verfahren zum Gasliften von Bohrlochflüssigkeiten (2) durch Einblasen von Liftgas (16) in einem unteren Bohrlochbereich in den Strom der Bohrlochflüssigkeiten (2), **dadurch gekennzeichnet, daß** das Liftgas (16) als ein Agglomerat aus fein dispergierten Bläschen (16) in den Strom der Bohrlochflüssigkeiten (2) eingeblasen wird.

2. Verfahren nach Anspruch 1, bei welchem das Liftgas (16) in den Strom der Bohrlochflüssigkeiten (2) über eine poröse Wand (18) eingeblasen wird, in welcher eine Anordnung von Liftgas-Einblasöffnungen vorgesehen ist.

3. Verfahren nach Anspruch 2, bei welchem die Durchschnittsweite der Einblasöffnungen weniger als 0,5 mm beträgt.

4. Verfahren nach Anspruch 3, bei welchem die Durchschnittsweite der Einblasöffnungen weniger als 0,1 mm beträgt.

5. Verfahren nach Anspruch 4, bei welchem die poröse Wand (15) durch eine poröse Membrane gebildet ist.

6. Verfahren nach Anspruch 2, bei welchem die poröse Wand (15) eine rohrförmige Gestalt hat und Teil eines rohrförmigen Gaseinblasdornes bildet, der lösbar in eine Seitentasche (3) einer Förderverrohrung (1) eingesetzt ist, derart, daß im Betrieb Liftgas (16) über einen Ringraum (6), welcher die Förderverrohrung (1) umgibt, in das Innere des Dornes (4) eingeblasen und dann über die poröse Wand (15) in den Strom der Bohrlochflüssigkeiten (2) in der Förderverrohrung (1) ausgestoßen wird.

7. System zum Gasliften von Bohrlochflüssigkeiten (2), wobei das System **gekennzeichnet ist durch** eine poröse Wand (15), in welcher eine Anordnung von Liftgas-Einblasöffnungen vorgesehen ist, **durch** welche Öffnungen im Betrieb Liftgas (16) als

ein Agglomerat von fein dispergierten Bläschen (16) in den Strom der Bohrlochflüssigkeiten (2) eingeblasen wird.

Fig.1.

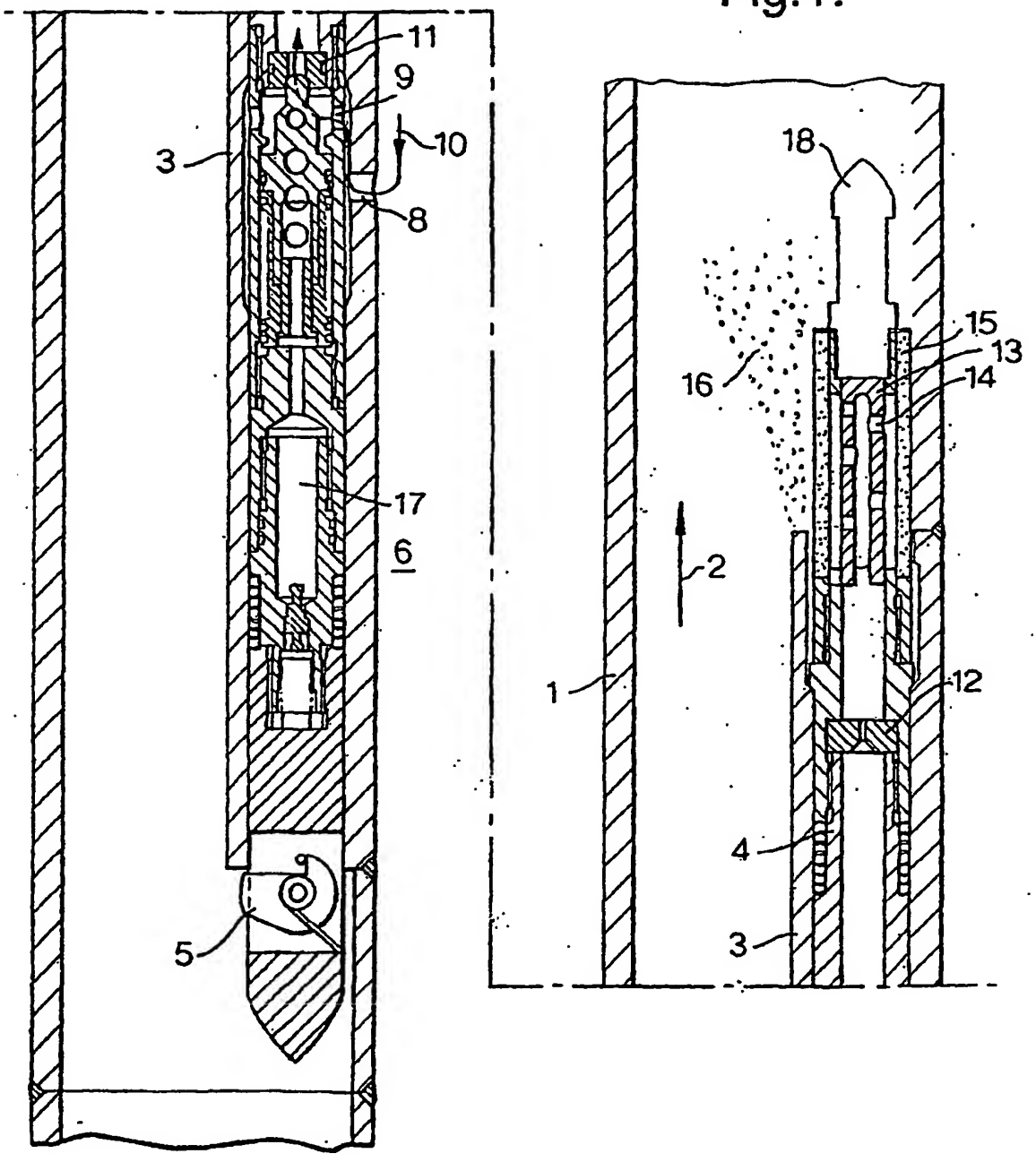

Fig.2.

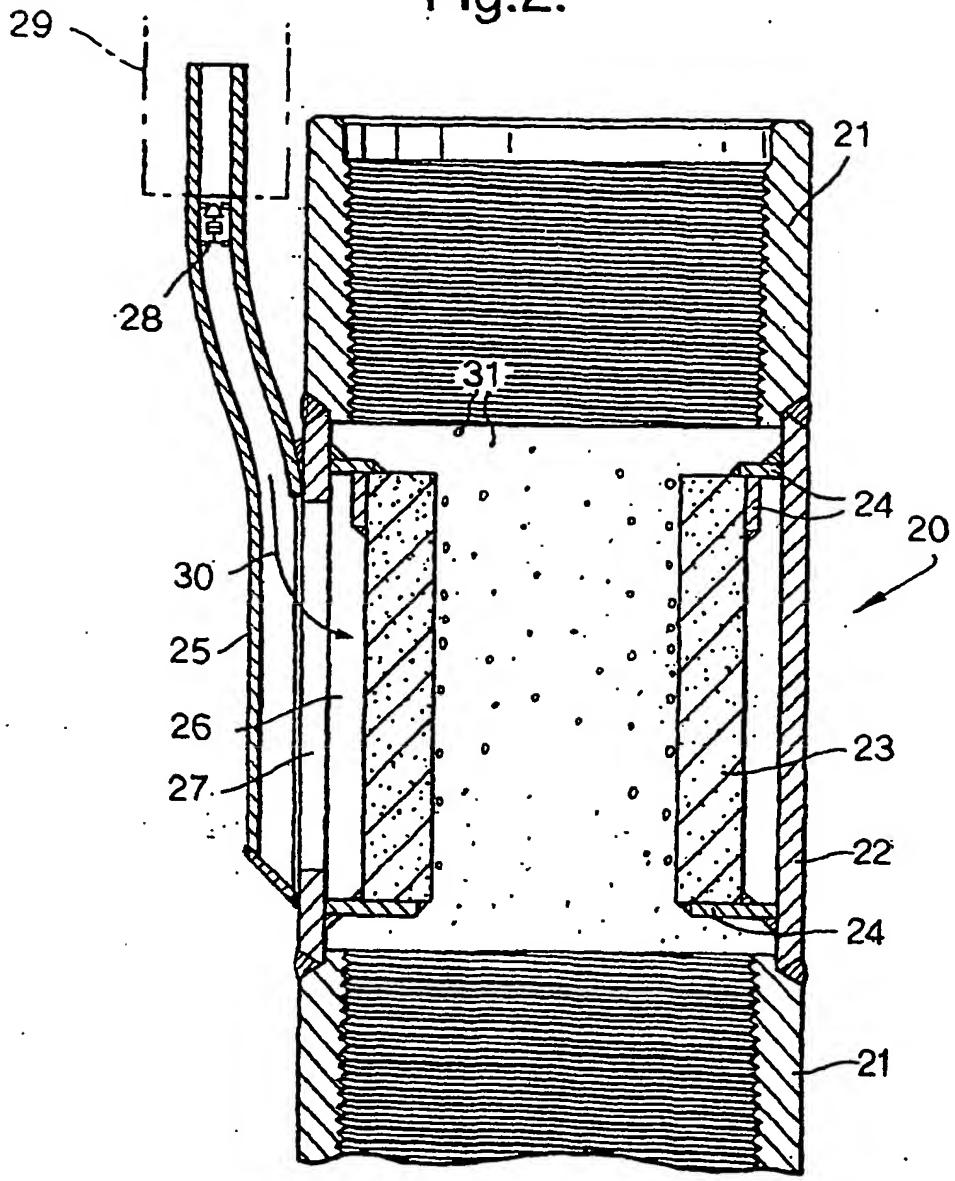

Fig.3.

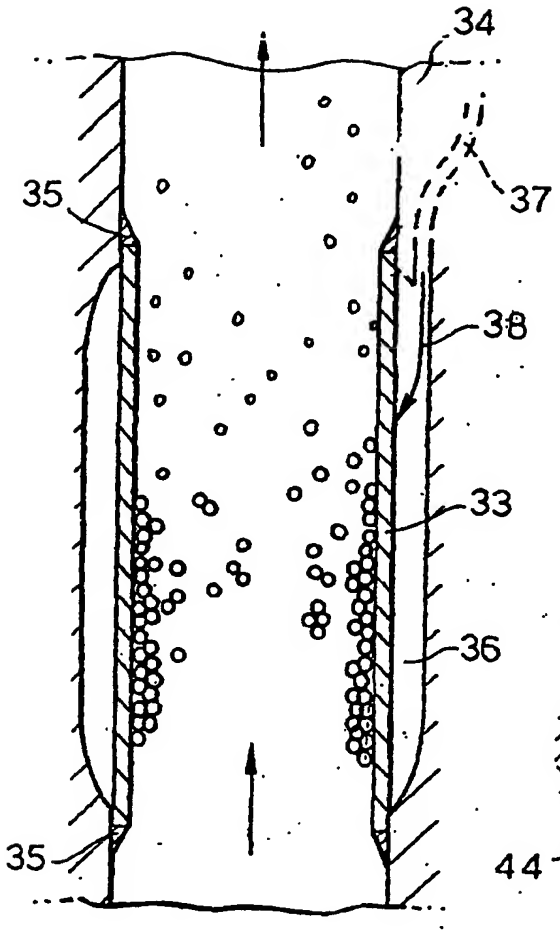

Fig.4.

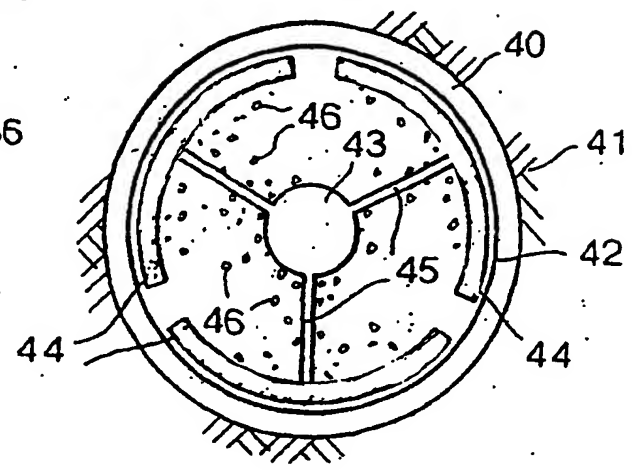

Fig.5.